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ABSTRACT

This lesson plan is intended for use in conducting classes on photosynthesis. Presented first are an attention step/problem statement and a series of questions and answers designed to convey general information about photosynthesis. The following topics are among those discussed: the photosynthesis process and its importance, the organisms that can conduct photosynthesis, items needed for photosynthesis and factors that affect photosynthesis rate, the way plants receive nutrients, the importance of the plant leaf during photosynthesis, plant leaf components and their function, factors conducive to photosynthesis, the chemical formula for photosynthesis, and the steps of energy production during photosynthesis. Also provided are the following: a glossary of pertinent scientific terms, 4 worksheets, answers to the worksheets, 2 quizzes, answers to the quizzes, 12 overhead transparency masters, and a lesson plan for teaching students to compare plants growing at different levels of light. Included in the lesson plan are an objective, list of equipment needed, detailed steps for completing the activity, and student activity record sheet. (MN)

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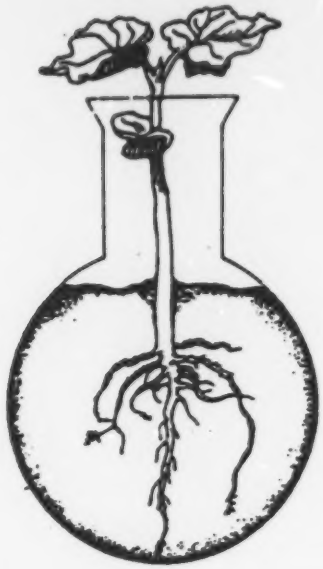

Agricultural Lesson Plans

PHOTOSYNTHESIS

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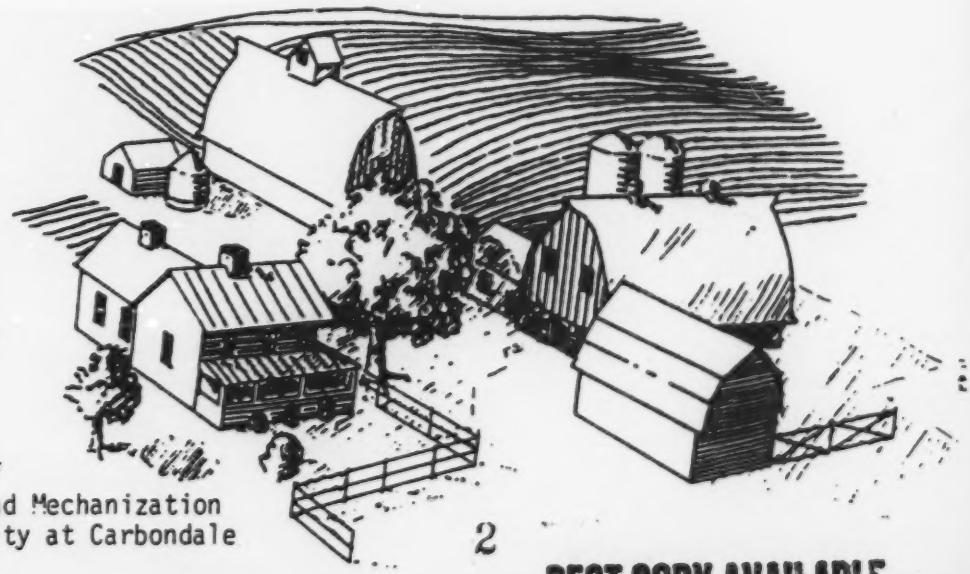

CE 065 308

Department of
Agricultural Education and Mechanization
Southern Illinois University at Carbondale

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PHOTOSYNTHESIS

ATTENTION STEP/PROBLEM STATEMENT

I left a board laying in the grass last week. Why is the grass under the board a pale green -- almost white?

The grass isn't getting enough light, so there is abnormal chlorophyll development. The stems are weak because its trying to grow fast, so it can reach the light.

Questions:

1. What is photosynthesis ?
   - Photosynthesis is the process in which green plants make food. Only algae and green plants have the ability to manufacture sugar from carbon dioxide and water when sunlight is present.

2. Why is photosynthesis important ?
   - Almost all plants and animals depend on photosynthesis. Green plants use photosynthesis to create food for themselves, for animals, and people. Photosynthesis uses the waste materials (carbon dioxide and water) from respiration, combustion, and oxidation. Photosynthesis is also the most important source of atmospheric oxygen.

3. What organisms can conduct photosynthesis ?
   - Only algae and plants containing the green material chlorophyll can carry on photosynthesis. Chlorophyll is found in the chloroplast of a plant cell.

4. List four items needed for photosynthesis ?
   - Plants require four things to carry on photosynthesis: carbon dioxide, water, sunlight, and chlorophyll.

5. What are the factors which affect the rate of photosynthesis ?
   - Factors that affect the photosynthetic rate are: the water supply, amount of carbon dioxide available, temperature, light quality and intensity, and availability of certain plant nutrients.

6. How are plant nutrients provided to plants ?
   - Plant nutrients are provided to plants by mineral salts. Mineral salts are found dissolved in the water in the soil. Fertilizer increases the amount of mineral salts in the soil. The mineral salts are used by the plant to produce plant oils, protein, chlorophyll, and ATP.

7. **What is the Importance of the Plant Leaf during Photosynthesis ?**

   - The main area of photosynthetic activity is the plant leaf. Leaves are the food-making organ of most plants, but photosynthesis can occur in other parts of a plant.

8. What are the important internal structures of the leaf ?
   - The internal structure of a foliage leaf include: the cuticle, epidermis, food-making cells, veins, stomates, and guard cells.

9. What is the purpose of the cuticle ?
   - The cuticle is a waxy, waterproof layer that reduces water loss from the leaves.

10. Where is the epidermis located ?
    - The epidermis is the surface layer of cells that include both the top and bottom of leaf.

11. What is the purpose of the food making cells ?
    - Food-making cells contain chloroplasts where chlorophyll is found. The two types of food-making cells are the palisade cells and the spongy cells. The palisade cells are elongated and are arranged vertically close to the epidermis. There are usually one or two layers of palisade cells. The spongy cells are loosely packed with large spaces between the cells. The large spaces aid in the diffusion of gases to the cells.

12. What is the function of the veins ?
    - Water enters the leaf through veins. Veins also carries dissolved food from the leaf to other plant parts.

13. What is the purpose of the stomates ?
    - Stomates are air spaces on the bottom side of leaves.

14. What is the function of the guard cells ?
    - Guard cells control the opening and closing of stomates.

15. Why are leaves generally flat and thin ?
    - Leaves are generally thin and flat so most of their cells can catch sunlight. Any wavelength of light may be used by a plant to carry on photosynthesis. Too bright of sunlight may inhibit the rate photosynthesis occurs in plants. Too little light will limit when photosynthesis occurs.

16. Where is chlorophyll found ?
    - Chlorophyll is found in the chloroplasts of a plant cell. A high concentration of chloroplasts are found in the interior portion of the leaf or food-making cells. Red and blue-violet light rays are absorbed by the chlorophyll and green light is reflected by the chlorophyll.

17. What affect does the amount of carbon dioxide in the air have on photosynthesis ?
    - The amount of carbon dioxide in the air can be a limiting factor for photosynthesis, so an increase in carbon dioxide in the air can increase the plant's ability to carry on photosynthesis. For this reason, greenhouses may use carbon dioxide injectors to increase the amount of carbon dioxide in the air during the winter when greenhouse vents are closed.

18. What temperatures are good for photosynthesis ?
    - Generally, for photosynthesis to occur the temperature must be between 5°C - 45°C (40°F - 110°F).

19. What is the chemical formula for photosynthesis ?

The chemical formula for photosynthesis is:

$$6\ CO_2 + 6\ H_2O \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_6H_{12}O_6 + 6\ O_2$$

Carbon dioxide + water $\xrightarrow[\text{chlorophyll}]{\text{sunlight}}$ glucose + oxygen

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20. What are the steps in producing energy by photosynthesis ?
    During photosynthesis, sunlight shines on a plant's leaves and the light energy is absorbed by the chloroplasts inside the plant cells. The chlorophyll molecules inside the chloroplasts change the light energy into chemical energy. A molecule is the smallest particle of an element or compound that can exist in the free state and still retain the characteristics of the element or compound. This transfer of energy produces the energy storing unit ATP.

21. How does the plant use water in the process of photosynthesis?
The water that is used during photosynthesis is absorbed by the plant's roots and travels to the food- making cells of a leaf through the xylem tissue and leaf veins. Xylem is a conductive tissue in plants that carries water from the roots to the other plant parts. In the plant's food-making cells, some of the water molecules (H_2O) are split into hydrogen (H) and oxygen (O_2). The oxygen is given off into the atmosphere. The hydrogen is stored in a compound in the food-making cells of the leaf. This compound stores the hydrogen necessary for the production of sugar during photosynthesis.

22. What role does carbon dioxide play in photosynthesis ?
Carbon dioxide (CO_2) enters the leaf through the stomates. The amount of carbon dioxide allowed into a leaf is controlled by the guard cells. The guard cells regulate the opening and closing of the stomates. The carbon dioxide enters the air spaces of the leaf and moves into the leaf's food-making cells.

23. What items are part of the sugar making process ?
Using ATP as an energy source, the stored hydrogen is transferred to organic compounds. Through a series of reactions, carbon dioxide is then incorporated with these compounds to make sugar.

24. How does sugar move through the plant ?
After photosynthesis occurs, the sugar which is formed is transported by the phloem tissue to the plant part where it will be stored or used. Phloem is the conductive tissue in a plant that carries sugars and minerals from leaves to other parts of a plant.

GLOSSARY OF TERMS:

ATP -	Adenosine triphosphate, major energy transferring molecule in biological systems.
chlorophyll -	green material in plants used in making food.
chloroplast -	organelle containing chlorophyll.
cuticle -	waxy, waterproof layer that reduces water loss from the leaves.

epidermis -	surface layers of cells on plant leaf.
fertilizer -	materials put on soil to increase fertility and improve plant growth.
food-making cells -	contain chloroplasts where chlorophyll is found.
glucose -	simple sugar manufactured by green plants.
guard cells -	cells that control the opening and closing of the stomates.
mineral salts -	minerals that are dissolved in the water in the soil.
molecule -	the smallest particle of an element or compound that can exist in the free state and still retain the characteristics of the element or compound.
palisade cells -	the elongated food-making cells found near the epidermis.
phloem -	the conductive tissue in a plant that carries sugars and minerals from the leaves to other parts of a plant.
photosynthesis	process in which green plants convert water and carbon dioxide in the presence of light into sugar with oxygen being released into the atmosphere as a by-product.
spongy cells -	the loosely packed food-making cells.
stomates -	air spaces on the bottom side of leaves.
veins -	carries water to leaf and dissolved food away from the leaf.
xylem -	conductive tissue in plants that carries water from the roots to other plant parts.

WORK SHEET A

Directions: Complete the following questions.

A. Fill-in-the-blank:

1. _____ is the process in which green plants make food.

2. Green plants use photosynthesis to create food for _____ and _____.

3. Only plants containing the green material _____ can carry on photosynthesis.

4. Plants require _____, _____, sunlight, and chlorophyll to carry on photosynthesis.

5. The main area of photosynthetic activity on a plant is the _____.

6. Chlorophyll is found in the _____ of a plant cell.

7. Too _____ of sunlight may inhibit the rate photosynthesis occurs in plants while too _____ sunlight limits when photosynthesis occurs.

8. Generally, for photosynthesis to occur the temperature must be between _____ °C.- °C. *or* °F.- °F._____.

9. _____ is the most important source of atmospheric oxygen.

10. Fertilizer increases the amount of _____ in the soil.

WORK SHEET A ANSWERS

Directions: Complete the following questions.

A. Fill-in-the-blank:

1. ***Photosynthesis*** is the process in which green plants make food.

2. Green plants use photosynthesis to create food for ***themselves*** and ***animals or people***.

3. Only plants containing the green material ***chlorophyll*** can carry on photosynthesis.

4. Plants require ***carbon dioxide***, ***water***, sunlight, and chlorophyll to carry on photosynthesis.

5. The main area of photosynthetic activity on a plant is the ***leaf***.

6. Chlorophyll is found in the ***chloroplasts*** of a plant cell.

7. Too ***bright*** of sunlight may inhibit the rate photosynthesis occurs in plants while too ***little*** sunlight limits when photosynthesis occurs.

8. Generally, for photosynthesis to occur the temperature must be between ***5° C.-45° C. or 40° F.-110° F.***.

9. ***Photosynthesis*** is the most important source of atmospheric oxygen.

10. Fertilizer increases the amount of ***nutrients or mineral salts*** in the soil.

WORK SHEET B

Directions:

The answers to the following fill-in-the-blank questions are terms which have something to do with photosynthesis. Choose the term from the word list below that best answers each question. Each term may be used only once.

Word List:

ATP
chloroplasts
chlorophyll
cuticle
epidermis
fertilizer
food-making cells
glucose
guard cells
mineral salts
molecule
palisade cells
phloem
photosynthesis
spongy cells
stomates
veins
xylem

Fill-in-the-blank:

1. _____ is the process in which green plants convert water and carbon dioxide in the presence of light into sugar.

2. The green material in plants used in making food is called _____.

3. Organelles containing chlorophyll are called _____.

4. _____ is the simple sugar manufactured by green plants during photosynthesis.

5. _____ are air spaces on the bottom side of leaves. Their opening and closing is controlled by _____.

6. The _____ is the surface layers of cells on the plant leaf.

7. The _____ of the leaf contain the chloroplasts where the chlorophyll is found.

8. _____ carry water to the leaf and dissolved food away from the leaf.

9. The conductive tissue in a plant that carries sugars and minerals from the leaves to other parts of a plant is called _____.

10. _____ is the conductive tissue in plants that carries water from the roots to other plant parts.

11. The smallest particle of an element or compound that can exist and still retain the characteristics of the element or compound is a _____.

12. _____ is the major energy transferring molecule in biological systems.

13. _____ are found dissolved in the water of the soil.

14. Materials that are put on the soil to increase soil fertility and improve plant growth are called _____.

15. The _____ are the elongated food-making cells while the _____ are the loosely packed food-making cells of the leaf.

16. The _____ is the waxy waterproof layer that reduces water loss from the leaves.

WORK SHEET B ANSWERS

Word List:

ATP
chloroplasts
chlorophyll
cuticle
epidermis
fertilizer
food-making cells
glucose
guard cells
mineral salts
molecule
palisade cells
phloem
photosynthesis
spongy cells
stomates
veins
xylem

Fill-in-the-blank:

1. *Photosynthesis* is the process in which green plants convert water and carbon dioxide in the presence of light into sugar.
2. The green material in plants used in making food is called *chlorophyll*.
3. Organelles containing chlorophyll are called *chloroplasts*.
4. *Glucose* is the simple sugar manufactured by green plants during photosynthesis.
5. *Stomates* are air spaces on the bottom side of leaves. Their opening and closing is controlled by *guard cells*.
6. The *epidermis* is the surface layers of cells on the plant leaf.
7. The *food-making cells* of the leaf contain the chloroplasts where the chlorophyll is found.
8. *Veins* carry water to the leaf and dissolved food away from the leaf.
9. The conductive tissue in a plant that carries sugars and minerals from the leaves to other parts of a plant is called *phloem*.
10. *Xylem* is the conductive tissue in plants that carries water from the roots to other plant parts.
11. The smallest particle of an element or compound that can exist and still retain the characteristics of the element or compound is a *molecule*.
12. *ATP* is the major energy transferring molecule in biological systems.
13. *Mineral salts* are found dissolved in the water of the soil.
14. Materials that are put on the soil to increase soil fertility and improve plant growth are called *fertilizers*.
15. The *palisade cells* are the elongated food-making cells while the *spongy cells* are the loosely packed food-making cells of the leaf.
16. The *cuticle* is the waxy waterproof layer that reduces water loss from the leaves.

WORK SHEET C

Directions:

The answers to the following fill-in-the-blank questions are terms which have something to do with photosynthesis. Choose the term from the word list below that best answers each question. Each term may be used only once.

Word List:

ATP	**mineral salts**
chloroplasts	**molecule**
chlorophyll	**palisade cells**
cuticle	**phloem**
epidermis	**photosynthesis**
fertilizer	**spongy cells**
food-making cells	**stomates**
glucose	**veins**
guard cells	**xylem**

Fill-in-the-blank:

1. _____ is the process in which green plants convert water and carbon dioxide in the presence of light into sugar.
2. The green material in plants used in making food is called _____.
3. Organelles containing chlorophyll are called _____.
4. _____ is the simple sugar manufactured by green plants during photosynthesis.
5. _____ are air spaces on the bottom side of leaves. Their opening and closing is controlled by _____.
6. The _____ is the surface layers of cells on the plant leaf.
7. The _____ of the leaf contain the chloroplasts where the chlorophyll is found.
8. _____ carry water to the leaf and dissolved food away from the leaf.
9. The conductive tissue in a plant that carries sugars and minerals from the leaves to other parts of a plant is called _____.
10. _____ is the conductive tissue in plants that carries water from the roots to other plant parts.
11. The smallest particle of an element or compound that can exist and still retain the characteristics of the element or compound is a _____.
12. _____ is the major energy transferring molecule in biological systems.
13. _____ are found dissolved in the water of the soil.
14. Materials that are put on the soil to increase soil fertility and improve plant growth are called _____.
15. The _____ are the elongated food-making cells while the _____ are the loosely packed food-making cells of the leaf.
16. The _____ is the waxy waterproof layer that reduces water loss from the leaves.

Fill-in-the-blank: ANSWERS TO WORKSHEET C

1. *Photosynthesis* is the process in which green plants convert water and carbon dioxide in the presence of light into sugar.

2. The green material in plants used in making food is called *chlorophyll*.

3. Organelles containing chlorophyll are called *chloroplasts*.

4. *Glucose* is the simple sugar manufactured by green plants during photosynthesis.

5. *Stomates* are air spaces on the bottom side of leaves. Their opening and closing is controlled by *guard cells*.

6. The *epidermis* is the surface layers of cells on the plant leaf.

7. The *food-making cells* of the leaf contain the chloroplasts where the chlorophyll is found.

8. *Veins* carry water to the leaf and dissolved food away from the leaf.

9. The conductive tissue in a plant that carries sugars and minerals from the leaves to other parts of a plant is called *phloem*.

10. *Xylem* is the conductive tissue in plants that carries water from the roots to other plant parts.

11. The smallest particle of an element or compound that can exist and still retain the characteristics of the element or compound is a *molecule*.

12. *ATP* is the major energy transferring molecule in biological systems.

13. *Mineral salts* are found dissolved in the water of the soil.

14. Materials that are put on the soil to increase soil fertility and improve plant growth are called *fertilizers*.

15. The *palisade cells* are the elongated food-making cells while the *spongy cells* are the loosely packed food-making cells of the leaf.

16. The *cuticle* is the waxy waterproof layer that reduces water loss from the leaves.

WORK SHEET D

Directions: Complete the following questions.

A. Fill-in-the-blank:

1. During photosynthesis, _____ is provided to the leaf by the leaf veins and xylem cells.

2. The amount of _____ allowed into a leaf cell is controlled by the guard cells and stomates.

3. _____ is present in the chloroplasts of leaves.

4. When a sunbeam strikes a leaf, carbon dioxide and water are broken down and _____ is manufactured.

5. _____ is given off into the atmosphere as a reaction to the manufacturing process during photosynthesis.

6. After photosynthesis occurs, the sugar which is formed is transported by the _____ tissue to the plant part where it will be stored or used.

7. During photosynthesis, the chlorophyll molecules change the light energy into _____ energy.

8. Using _____ as an energy source, the stored hydrogen is transferred to organic compounds. Through a series of reactions, _____ is then incorporated with these compounds to make sugar.

B. Short Answer:

9. Write the chemical formula for photosynthesis.

10. What happens to the water (H_2O) molecule when it is split during photosynthesis?

WORK SHEET D **ANSWERS**

Directions: Complete the following questions.

A. Fill-in-the-blank:

1. During photosynthesis, ***water*** is provided to the leaf by the leaf veins and xylem cells.

2. The amount of ***carbon dioxide*** allowed into a leaf cell is controlled by the guard cells and stomates.

3. ***Chlorophyll*** is present in the chloroplasts of leaves.

4. When a sunbeam strikes a leaf, carbon dioxide and water are broken down and ***glucose*** is manufactured.

5. ***Oxygen*** is given off into the atmosphere as a reaction to the manufacturing process during photosynthesis.

6. After photosynthesis occurs, the sugar which is formed is transported by the ***phloem*** tissue to the plant part where it will be stored or used.

7. During photosynthesis, the chlorophyll molecules change the light energy into ***chemical*** energy.

8. Using ***ATP*** as an energy source, the stored hydrogen is transferred to organic compounds. Through a series of reactions, ***carbon dioxide*** is then incorporated with these compounds to make sugar.

B. Short Answer:

9. Write the chemical formula for photosynthesis.

$$6\,CO_2 + 6\,H_2O \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_6H_{12}O_6 + 6\,O_2$$

10. What happens to the water (H_2O) molecule when it is split during photosynthesis?

Hydrogen is transferred to a compound where it is stored and oxygen is released into the atmosphere.

STUDENT ACTIVITY -1

Comparing Plants Growing at Different Levels of Light

a. **Purpose:** compare plant growth and appearances when exposed to varying amounts of light.

b. **What Each Group of Students Needs:**

4 uniform plants
4 labels
pencils
rulers

c. **Here's How:**

1. Work in your assigned group.
2. Get 4 healthy plants of the same variety and the same size.
3. Number the plants 1 - 4.
4. Write the plant's number, the plant variety, name of students in your group, and date on a label using a pencil. (Do not use a pen because the ink will run if it gets wet.)
5. Insert a label in each of the pots.
6. Measure the height of each plant in centimeters. (Measure from the bottom of the pot to the tip of the plant shoot.)
7. Record the plant's measurements in Part A, #1 of the Student Activity - 1 Record Sheet.
8. Examine each plant and record observations in Part B, #1 of the Student Activity - 1 Record Sheet.
9. Place plant #1 in a sunny location as instructed by your teacher. A greenhouse or sunny window is an ideal location.
10. Place plant #2 in bright indirect light as instructed by your teacher. A suitable location would be an area which receives direct light from the lights in your classroom or in a north or shady window.
11. Place plant #3 in a relatively dark area as instructed by your teacher. Plants could be placed under a table or in any other dark area of the classroom.
12. Place plant #4 in complete darkness as instructed by your teacher. Darkness can be achieved by placing plants in a dark closet or under an over turned box.
13. Complete Part C of the Student Activity - 1 Record Sheet.
14. Water the plants as needed. The plants will probably require different amounts of water.
15. Measure and observe the plants once a week for at least two weeks.
16. Record your measurements and observations in Part A and Part B of the Student Activity - 1 Record Sheets.
17. Complete Student Activity - 1, Part D at the termination of the activity.

STUDENT ACTIVITY - 1
RECORD SHEET

A. Record of Plant Growth

	Plant #1	Plant #2	Plant #3	Plant #4
1. Height of plant in (cm) at beginning of activity.				
Date:	_____	_____	_____	_____
2. Height of plant in (cm) after 1 week.				
Date:	_____	_____	_____	_____
3. Height of plant in (cm) after 2 weeks.				
Date:	_____	_____	_____	_____

B. Record of Plant Appearance

	Plant #1	Plant #2	Plant #3	Plant #4
1. Observations at beginning of activity. (Include color of plant, condition of stems, condition of leaves.)				
Date:_____				
2. Observations after 1 week. (Include color of plant, condition of stems, condition of leaves.)				
Date:_____				
3. Observations after 2 weeks. (Include color of plant, condition of stems, condition of leaves.)				
Date:_____				

C. Predictions

Answer the questions below and record your predictions at the beginning of student activity - 1 Comparing Plants Growing at Different Levels of Light.

1. What do you predict will happen to each of the 4 plants? Think about the following questions and write your predictions below. (Which plant will grow the most? Why? Which plant will grow the least? Why? Which plant will look the healthiest? Why? Which plant will suffer from the conditions the most? Why?)

Plant 1

Answers will vary.

Plant 2

Plant 3

Plant 4

D. Conclusions:

Answer the questions below and record your results at the completion of the student activity - 1 Comparing Plants Growing at Different Levels of Light.

1. **Which plants grew the most?**

   Answers will vary on each of these 7 questions. Environmental conditions and plant species will affect student answers.

2. **Which plants grew the least?**

3. **Which plants appear the healthiest?**

4. **Compare the growth of the 4 plants.**

5. **Are there other environmental factors other than light intensity that could affect the results? If yes, explain what the environmental factors are.**

6. **How do the results compare with your predictions?**

7. **How do the results compare with what you know about the intensity of light absorbed by chlorophyll?**

QUIZ 1

A. Matching

Match the best definition with each term:

_____	1. Chlorophyll	a.	Materials put on soil to increase fertility and improve plant growth.
_____	2. Photosynthesis	b.	green material in plants used in making food.
_____	3. Glucose	c.	minerals that are dissolved in the water in the soil.
_____	4. Mineral Salts	d.	process in which green plants convert water and carbon dioxide in the presence of light into sugar with oxygen being released into the atmosphere as a by-product.
_____	5. Fertilizer		
		e.	simple sugar manufactured by green plants.

B. True or False:

_____ 6. Only algae and green plants containing chlorophyll can carry on photosynthesis.

_____ 7. The stem is the main area of photosynthetic activity on a plant.

_____ 8. Too little sunlight may inhibit the rate photosynthesis occurs in plants while too bright of sunlight limits when photosynthesis occurs.

C. Short Answer:

9. What four things do plants require to carry on photosynthesis?

10. Why is photosynthesis important to us and the world we live in?

QUIZ 1 ANSWERS

A. Matching

Match the best definition with each term:

b	1. Chlorophyll	a.	Materials put on soil to increase fertility and improve plant growth.
d	2. Photosynthesis	b.	green material in plants used in making food.
e	3. Glucose	c.	minerals that are dissolved in the water in the soil.
c	4. Mineral Salts	d.	process in which green plants convert water and carbon dioxide in the presence of light into sugar with oxygen being released into the atmosphere as a by-product.
a	5. Fertilizer		
		e.	simple sugar manufactured by green plants.

B. True or False:

T 6. Only algae and green plants containing chlorophyll can carry on photosynthesis.

F 7. The stem is the main area of photosynthetic activity on a plant.

F 8. Too little sunlight may inhibit the rate photosynthesis occurs in plants while too bright of sunlight limits when photosynthesis occurs.

C. Short Answer:

9. What four things do plants require to carry on photosynthesis?

Plants require 4 things to carry on photosynthesis: carbon dioxide, water, sunlight, and chlorophyll.

10. Why is photosynthesis important to us and the world we live in?

Photosynthesis supplies plants, animals, and people with food. Photosynthesis is also the most important source of atmospheric oxygen.

QUIZ 2

A. Matching:

Match the best definition with each term.

_____	1. Chloroplast	a.	air spaces on the bottom side of leaves.
_____	2. Epidermis	b.	surface layers of cells on plant leaf.
_____	3. Food-making cells	c.	cells that control the opening and closing of the stomates.
_____	4. Guard Cells	d.	organelle containing chlorophyll.
_____	5. Stomates	e.	contains the chloroplasts where the chlorophyll is found.

B. Short Answer:

6. Write the chemical formula for photosynthesis.

7. What happens to the water (H_2O) molecule when it is split during photosynthesis?

8. What does the plant do with the food it makes?

C. Fill-in-the-Blank:

9. During photosynthesis, sunlight energy is changed into chemical energy and produces _____.

10. ATP is used as an energy source to combine _____ with carbon dioxide to make sugar.

QUIZ 2 ANSWERS

A. Matching:

Match the best definition with each term.

d	1. Chloroplast	a.	air spaces on the bottom side of leaves.
b	2. Epidermis	b.	surface layers of cells on plant leaf.
e	3. Food-making cells	c.	cells that control the opening and closing of the stomates.
c	4. Guard Cells	d.	organelle containing chlorophyll.
a	5. Stomates	e.	contains the chloroplasts where the chlorophyll is found.

B. Short Answer:

6. Write the chemical formula for photosynthesis.

The chemical formula for photosynthesis is:

$$6\,CO_2 + 6\,H_2O \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_6H_{12}O_6 + 6\,O_2$$

7. What happens to the water (H_2O) molecule when it is split during photosynthesis?

Hydrogen is transferred to a compound where it is stored and oxygen is released into the atmosphere.

8. What does the plant do with the food it makes?

The sugar which is formed is transported by the phloem tissue to the plant part where it will be used or stored.

C. Fill-in-the-Blank:

9. During photosynthesis, sunlight energy is changed into chemical energy and produces ___*ATP*___.

10. ATP is used as an energy source to combine ___*hydrogen*___ with carbon dioxide to make sugar.

OH1

IMPORTANCE OF PHOTOSYNTHESIS

Almost all Plants, Animals, and People depend on Photosynthesis for food.

Photosynthesis is the most important source of atmospheric Oxygen.

OH2

REQUIREMENTS FOR PLANTS TO CARRY ON PHOTOSYNTHESIS:

Carbon Dioxide

Water

Sunlight

Chlorophyll

OH3

FACTORS AFFECTING PHOTOSYNTHETIC RATE

Water Supply

Availability of Carbon Dioxide

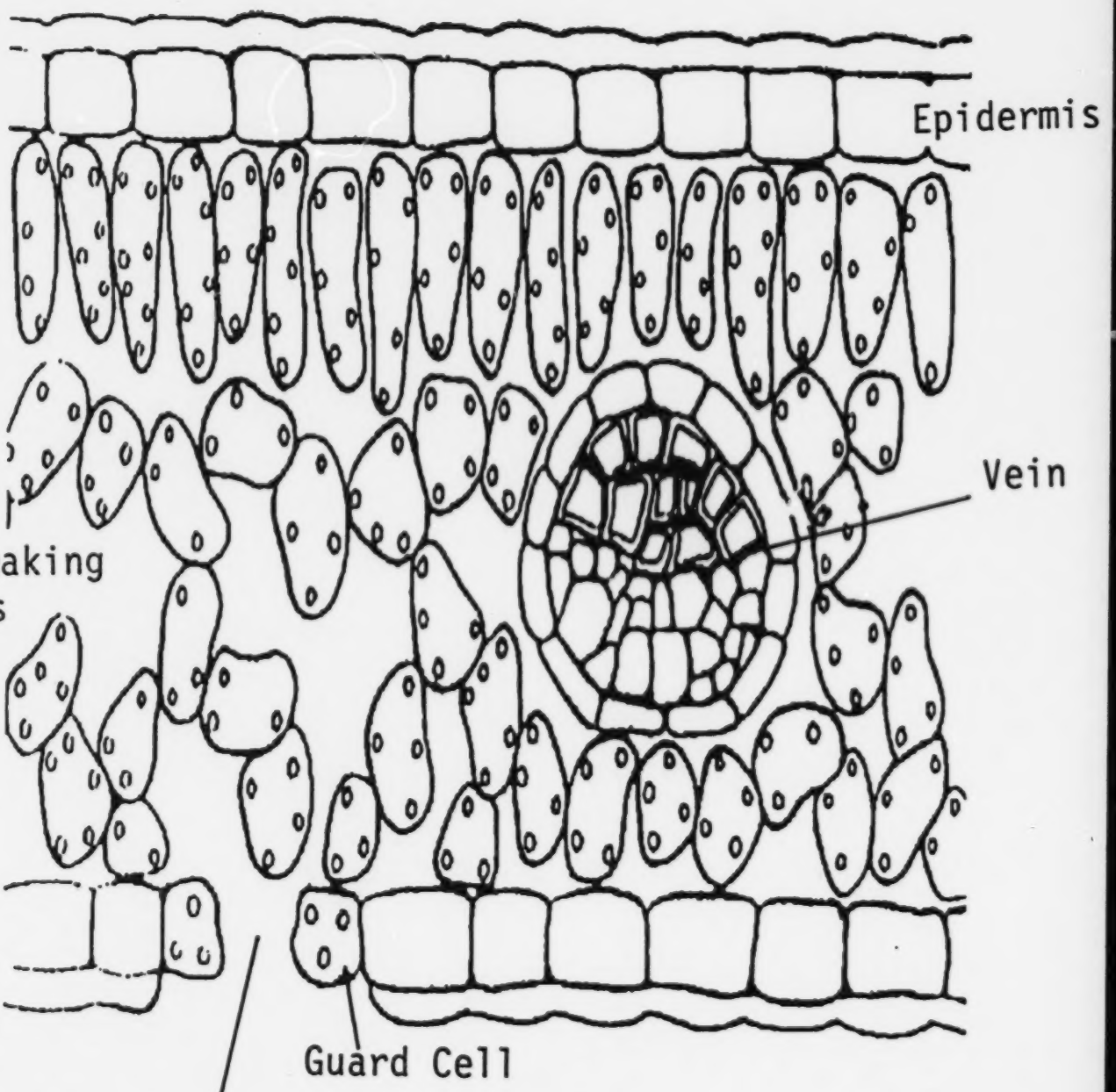
Temperature

Light Quality and Intensity

Availability of Plant Nutrients

OH4

INTERNAL STRUCTURE OF FOILAGE LEAF



OH5

HOW AMOUNT OF LIGHT AFFECTS PHOTOSYNTHESIS

Too Bright of Light Inhibits
Photosynthetic Rate

Too Little Light Limits
Photosynthetic Rate

OH6

TEMPERATURE FOR PHOTOSYNTHESIS TO OCCUR

5°C - 45°C

(40°F - 110°F)

OH7

CHEMICAL FORMULA FOR

PHOTOSYNTHESIS

$$6\ CO_2 + 6\ H_2O \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_6H_{12}O_6 + 6\ O_2$$

$$\text{carbon dioxide} + \text{water} \xrightarrow[\text{chlorophyll}]{\text{sunlight}} \text{glucose} + \text{oxygen}$$

OH8

LIGHT PHASE OF

PHOTOSYNTHESIS

Sunlight energy is changed into chemical energy and produces ATP.

Water molecules are split into Hydrogen and Oxygen. The oxygen is given off into the atmosphere. The hydrogen is stored for the production of sugar.

Carbon dioxide moves into the food-making cells.

OH9

DARK PHASE OF PHOTOSYNTHESIS

ATP is used as an energy source to combine hydrogen with carbon dioxide to make sugar.

OH10

TRANSPORTING

THE SUGAR

Sugar that is formed during photosynthesis is transported by phloem to the plant part where it will be stored or used.